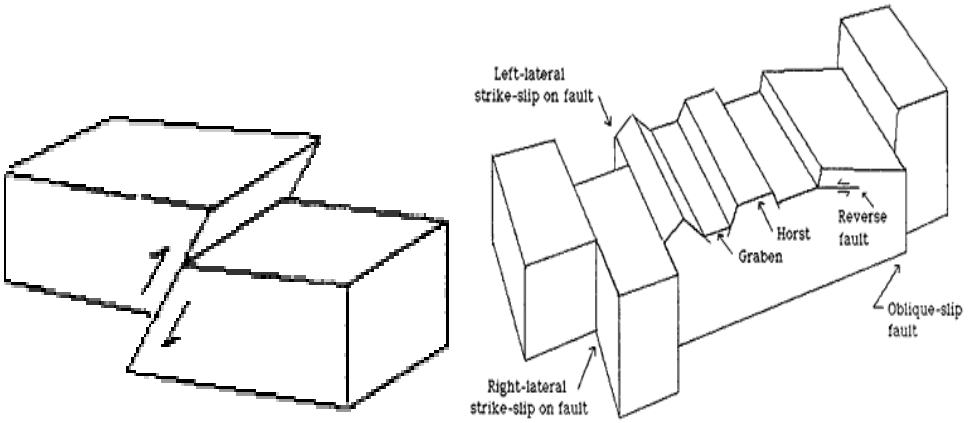
Let's Talk Water – Geology of Eastern Nevada and the Occurrence of Ground Water

By Dr. Mike Strobel

It is difficult to summarize the geology of eastern Nevada in a short article because it is quite complex. However, it is important to understand the geology because it is what controls the occurrence and movement of ground water in this region. Therefore, we will take a broad view of regional geology and discuss how it relates to water.

Eastern Nevada is part of the Great Basin, which is a physiographic area that covers pretty much all of Nevada and western Utah, stretching from the Wasatch Range near Salt Lake City to the Sierra Nevada, and slightly extends into Oregon, Idaho, and California. This large area actually is comprised of hundreds of smaller basins, each surrounded by topographic high areas, or ranges. This is why we refer to this part of the west as the Basin and Range…lots of basins and lots of ranges. It is best described as a collection of north- to northeast trending mountain ranges separated by broad alluvial desert basins.

A complex series of events created the Basin and Range topography. In the geologic past, the area has undergone both compression that pushed land masses together and extension that pulled land apart. The compression created some of the present mountain ranges, whereas the extension is what produced many of the present-day basins. The two diagrams below illustrate these actions:



The image on the left shows thrust faulting, which can occur when two land masses are pushed together (compression) creating mountain ridges. The image on the right shows features referred to as horst and grabens. These are German terms for ridges and trenches and these can occur when land is pulled apart (extension) and some blocks of land drop down relative to other blocks of land. The result is the basin and range topography of Nevada.

As one would imagine, all this compression and extension has produced some pretty deformed geology within the region. Mapping the geology is not a simple task, and the type of rocks in one basin may be quite different from those in adjacent basins. Plus, because of the thrusting, faulting, and shifting of rocks, the bedrock in the ranges often is different than that in the basins. If geology controls ground-water flow, it's obvious that if the bedrock is not continuous, then flow can be disrupted. This is why we refer to basins as being "compartmentalized" such that there are barriers to ground-water flow between many basins and each basin can be its own hydrologic system.

For the most part, the geology of eastern Nevada consists of consolidated carbonate (such as limestone) or noncarbonate rocks, and basin fill. The carbonate rocks are typically fractured and jointed and these features have been widened by the solution of the rock by ground water (same action that forms caves and caverns). These rocks can be quite thick, with estimates ranging between 5,000 ft to 30,000 ft. This combination of high permeability due to fractures, joints and solution features, in addition to the large

thickness, is why the carbonate rocks make up an important aquifer in eastern Nevada. However, because of the issue of compartmentalization discussed above, it is not clear how connected the carbonate aquifer is from basin to basin. Some geochemical evidence shows that ground water moves more than 100 miles between basins in eastern Nevada.

The noncarbonate rocks in eastern Nevada include a wide range of rock types, including metamorphic (such as gneiss or schist) and igneous rocks (such as granite), fine-grained sedimentary rocks (such as shale and siltstone), and volcanic rocks (such as basalt). For the most part, these noncarbonate rocks tend to act as barriers to ground-water flow because of their low permeability. The exception would be some of the volcanic rocks, which can be aquifers if the conditions are right. In Fallon and in parts of southern Nevada, volcanic rocks serve as sources of water for users. The consolidated carbonate and noncarbonated rocks are the bedrock that forms the mountain ranges and underlies unconsolidated basin-fill sediments in the valleys.

The third type of geology is the basin fill. These are the unconsolidated sediments (such as sand, gravel, and clay) that were eroded off of the mountains and deposited in the basins by streams. The thickness of the basin fill really depends on the local geology (how resistive the surrounding mountains are to erosion) and the depth of the basins between the ranges. The thickness of basin fill in eastern Nevada can range between thin deposits to greater than 10,000 ft. The basin fill also acts as an aquifer for much of the region and most ground water used in eastern Nevada is pumped from basin fill aquifers. The degree of ground-water flow from basin fill in one basin to another depends on the topography (is the basin fill isolated or does it extend between basins where one basin is higher than another) and bedrock geology of the ranges (can water move through the ranges or is it impermeable). Just like the geology of the Basin and Range, the hydraulic connection between basins is highly variable.

An important aspect of the hydrogeology of the Basin and Range is the connection between the basin fill aquifers and the carbonate aquifers that underlie some basins. This is important because it can affect recharge to the carbonate aquifers. Plus, it can mean

that factors affecting one aquifer, such as pumping stresses, may affect the other aquifer. This can go both ways, where pumping in the basin fill aquifer may affect ground-water recharge to the underlying bedrock aquifer, and pumping from the bedrock aquifer may affect water levels in the overlying basin fill aquifer. There is no simple answer to this because each basin is unique and different. Specific research on a particular basin or group of basins is needed to truly understand how the hydrology will be affected by different stresses.

So, we can see that the geology and hydrogeology of eastern Nevada is both interesting and complex. The more we learn about the factors that affect the movement of water in specific basins, the more we will understand the overall hydrogeology of all of eastern Nevada.

If you have questions concerning water, please contact me in care of the Ely Times or email me at mstrobel@usgs.gov. Next week, we will discuss the term Hydraulic Conductivity.